Peritoneal Dialysis
In
Acute Kidney Injury

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NMGH

NEPHROLOGY DEPARTEMENT
NMGH

Outline

1. Introduction & evidence of PD in AKI
2. Indications for acute PD & Contraindications to acute PD
3. Techniques of acute PD & Treatment schedule
4. Prescription of acute PD
5. Complications of acute PD
6. Acute PD in critically ill and hypercatabolic AKI patients

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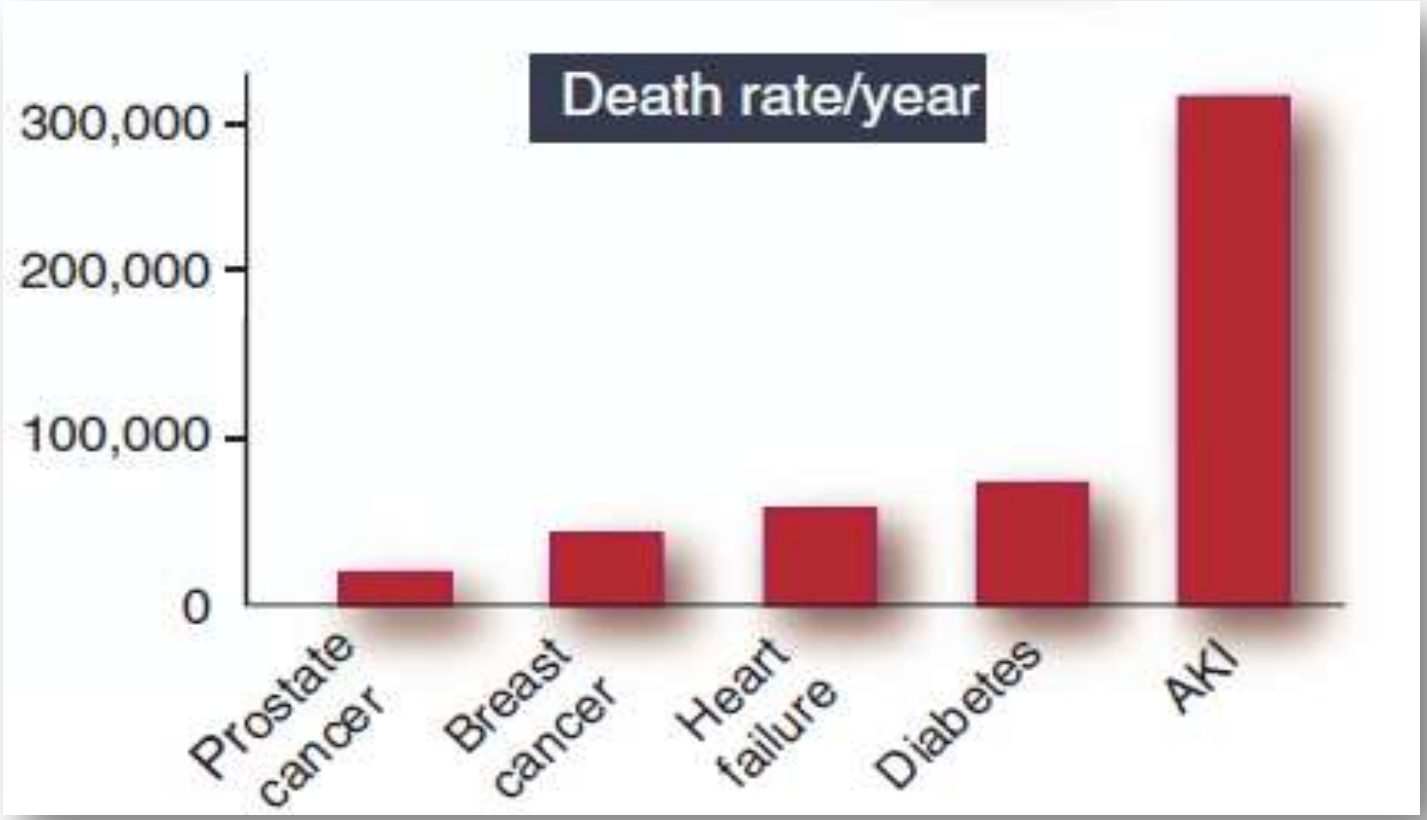
Mortality in AKI

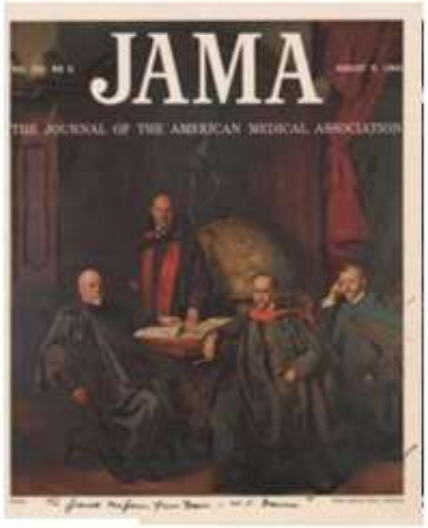


Kidney International May 2013

JAMA. 1959;170(8):917-924

PERITONEAL DIALYSIS

1. TECHNIQUE AND APPLICATIONS



1. Morton H. Maxwell, M.D.;
2. Robert E. Rockney, M.D.;
3. Charles R. Kleeman, M.D.;
4. Mary R. Twiss, R.N.

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PD … the modality first used for the treatment of AKI

commercially prepared electrolyte solutions, special catheters, and a "closed system" of infusion and drainage. This was mechanically successful in 76 instances. Conditions treated satisfactorily included acute renal failure, barbiturate poisoning, intractable edema, hepatic coma, hypercalcemia, and chronic uremia. Although less efficient than the artificial kidney on an hourly basis, peritoneal lavage is easier to use over extended periods of time.

Use of Peritoneal Dialysis in AKI: A Systematic Review

Chang Yin Chionh,[†] Sachin S. Soni,[*‡] Fredric O. Finkelstein,[§] Claudio Ronco,[*‖] and Dinna N. Cruz[‖¶]*

Summary

Background and objectives The role of peritoneal dialysis in the management of AKI is not well defined, although it remains frequently used, especially in low-resource settings. A systematic review was performed to describe outcomes in AKI treated with peritoneal dialysis and compare peritoneal dialysis with extracorporeal blood purification, such as continuous or intermittent hemodialysis.

Design, setting, participants, & measurements MEDLINE, CINAHL, and Central Register of Controlled Trials were searched in July of 2012. Eligible studies selected were observational cohort or randomized adult population studies on peritoneal dialysis in the setting of AKI. The primary outcome of interest was all-cause mortality. Summary estimates of odds ratio were obtained using a random effects model.

Results Of 982 citations, 24 studies (n=1556 patients) were identified. The overall methodological quality was low. Thirteen studies described patients (n=597) treated with peritoneal dialysis only; pooled mortality was 39.3%. In 11 studies (7 cohort studies and 4 randomized trials), patients received peritoneal dialysis (n=392, pooled mortality=58.0%) or extracorporeal blood purification (n=567, pooled mortality=56.1%). In the cohort studies, there was no difference in mortality between peritoneal dialysis and extracorporeal blood purification (odds ratio, 0.96; 95% confidence interval, 0.53 to 1.71). In four randomized trials, there was also no difference in mortality (odds ratio, 1.50; 95% confidence interval, 0.46 to 4.86); however, heterogeneity was significant (I^2=73%, P=0.03).

Conclusions There is currently no evidence to suggest significant differences in mortality between peritoneal dialysis and extracorporeal blood purification in AKI. There is a need for good-quality evidence in this important area.

Clin J Am Soc Nephrol 8: 1649–1660, 2013. doi: 10.2215/CJN.01540213

Seminars in Dialysis

RENAL REPLACEMENT THERAPY IN ACUTE KIDNEY INJURY: WHEN, HOW AND HOW MUCH?

Peritoneal Dialysis in Acute Kidney Injury: Lessons Learned and Applied

Emmanuel A. Burdmann* and Rajasekara Chakravarthi†

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Conclusions

This review clearly shows that PD can be used as a RRT modality to treat AKI, either in and out the ICU setting. PD is a simple, safe, gentle, and efficient way to correct metabolic, electrolytic, acid–base, and volume disturbances generated by AKI. Recently, HVPD has shown a similar efficacy compared to daily hemodialysis in critically ill AKI patients. The use of PD techniques such as HVPD or CFPD or the association of PD and extracorporeal blood purification RRT methods can provide adequate dialysis dose even in hypercatabolic situations.

Peritoneal Dialysis as a Mode of Treatment for Acute Kidney Injury in Sub-Saharan Africa

John Callegari[a] Sampson Antwi[b] Grzegorz Wystrychowski[c]
Ewa Żukowska-Szczechowska[c] Nathan W. Levin[a] Mary Carter[a]

[a]Renal Research Institute and Sustainable Kidney Care Foundation, New York, N.Y., USA; [b]Komfo Anokye Teaching Hospital, Kumasi, Ghana; [c]Department of Internal Medicine, Diabetology and Nephrology, Medical University of Silesia, Zabrze, Poland

Conclusion

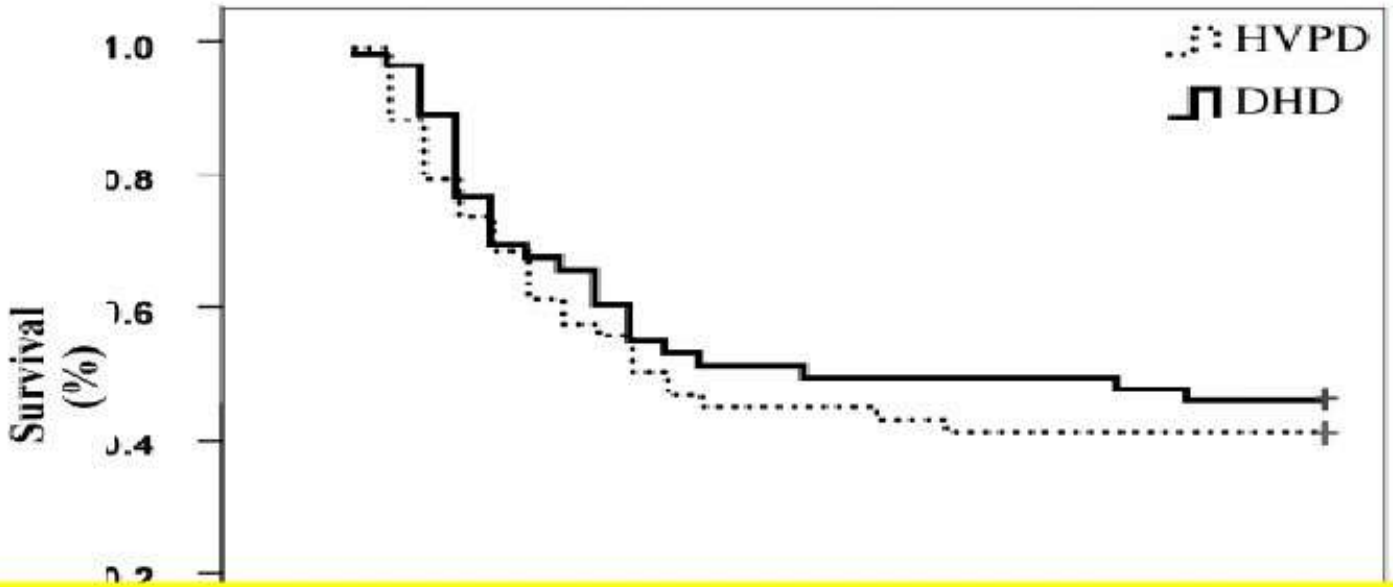
Measures to prevent kidney failure are important and need to be addressed. However, we cannot ignore those patients that are currently inflicted. Using PD to treat AKI as outlined can bring life-saving treatment to a large percentage of the affected population in many developing countries. It is more affordable than HD, can be started in the low-resource settings and is more desirable as a treatment option for children. While we will continue to strive to bring treatment for all with any form of kidney disease, we must not allow those with AKI to go untreated while waiting for the ability to treat everyone. Starting programs such as these can allow for many to go on and live productive and fulfilling lives.

Blood Purif 2013;36:226–230 DOI: 10.1159/000356627

CONTINUOUS PERITONEAL DIALYSIS COMPARED WITH DAILY HEMODIALYSIS IN PATIENTS WITH ACUTE KIDNEY INJURY

Daniela Ponce Gabriel, Jacqueline Teixeira Caramori, Luis Cuadrado Martin, Pasqual Barretti, and Andre Luis Balbi

Department of Internal Medicine, University Hospital, Botucatu School of



Conclusion

-High doses of CPD provided appropriate metabolic and pH control, with a rate of survival & recovery of renal function similar to that seen withdHD.

-CPD can be considered an alternative to other forms of RRT in AKI.

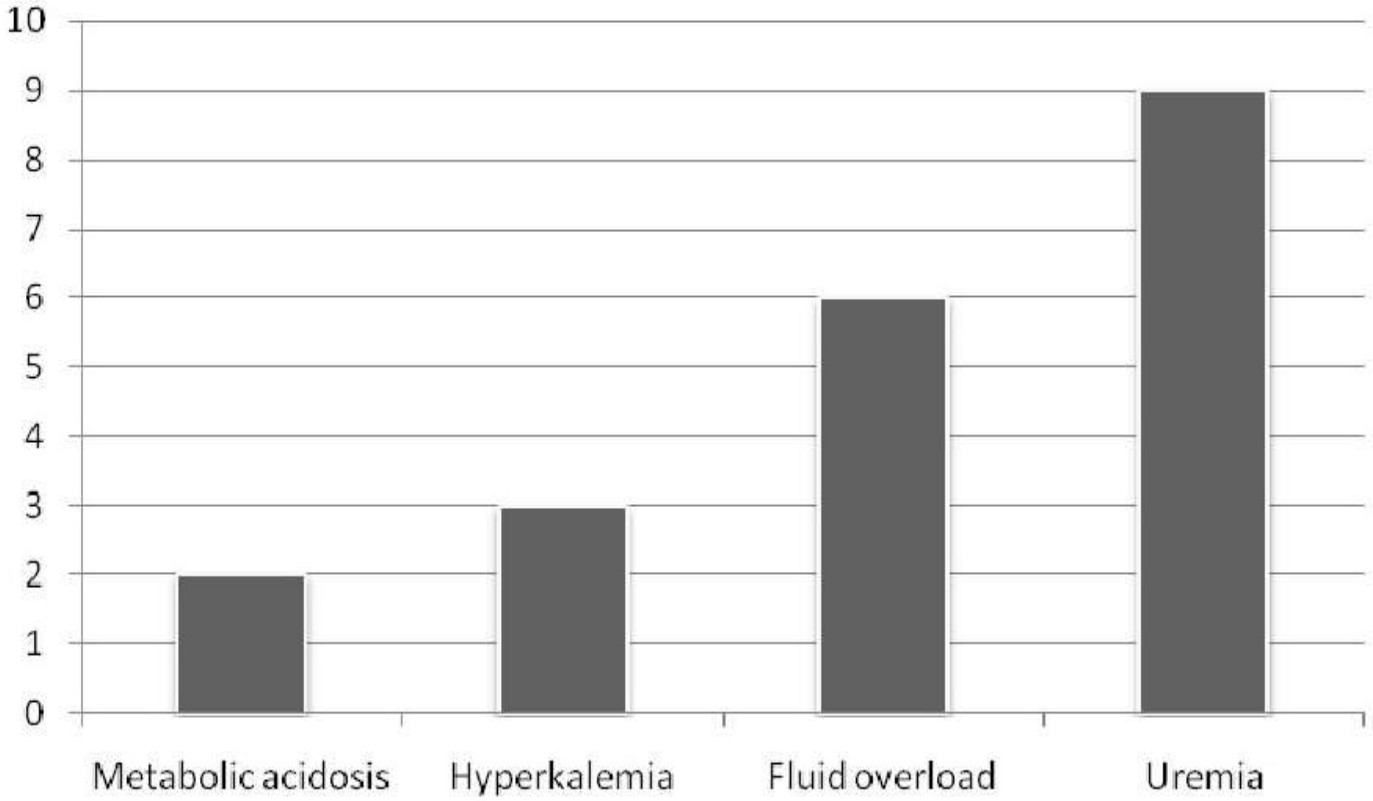
Gabriel D el al, Perit Dial Int 2007

JOURNAL OF THE INTERNATIONAL SOCIETY FOR PERITONEAL DIALYSIS
Peritoneal Dialysis INTERNATIONAL

PD AKI study in Srinagarind Hospital

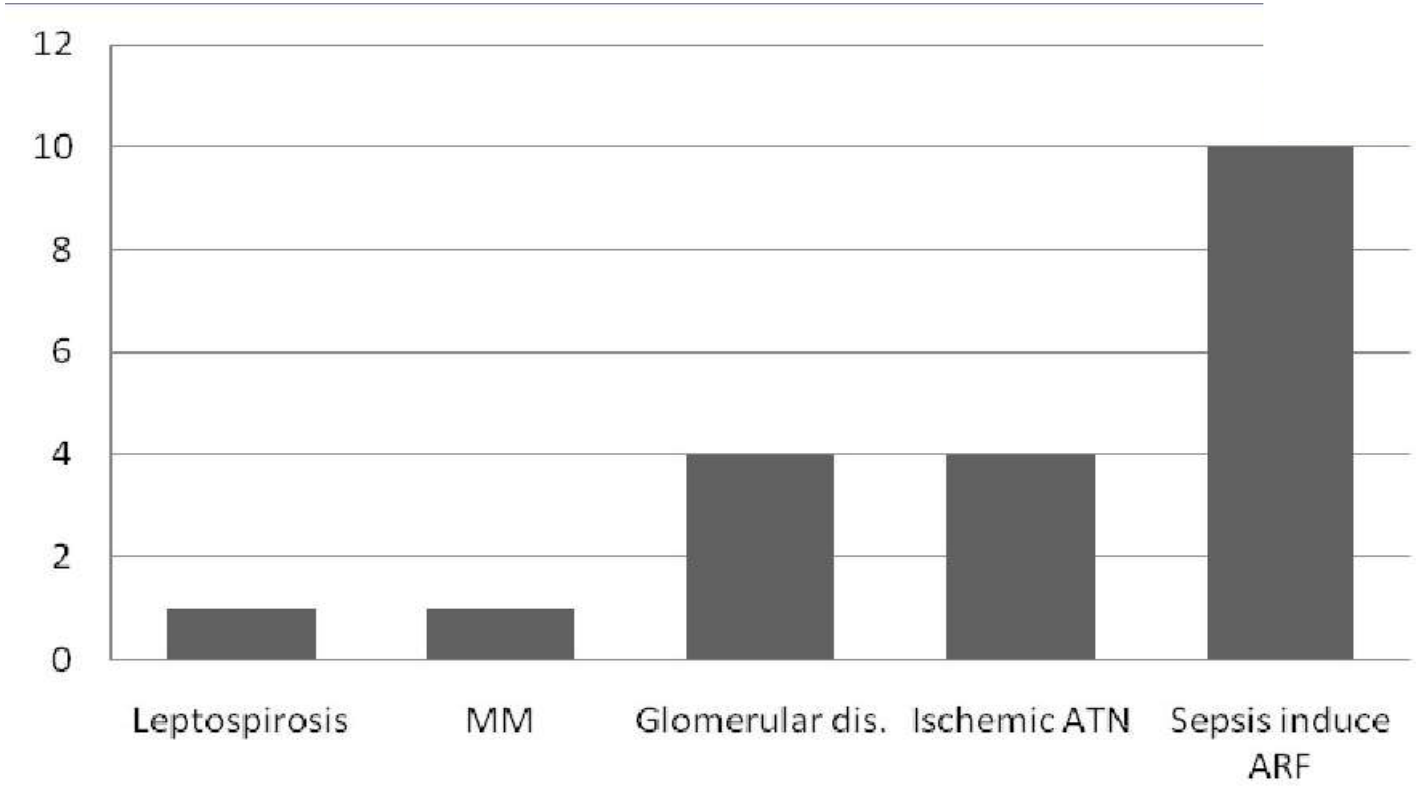
- 20 patients , 9 men and 11 women

Indication for PD



PD AKI study in Srinagarind Hospital

Etiology of AKI



PD AKI study in Srinagarind Hospital

Outcome

- ✓ Fluid removal was 1.51 L/day.
- ✓ Urea clearances was 7.68 mL/minute.

Complications:

- ✓ 15%secondary peritonitis
- ✓ 5%catheter dysfunction

Conclusion:

- **Acute peritoneal dialysis**
  - ➢ Good option for treatment of patient with AKI
  - ➢ Safe procedure & effective in controlling metabolic disorders in patients with AKI

Advances in Peritoneal Dialysis in Acute Kidney Injury

Daniela Ponce[a] André Luís Balbi[a] Richard Amerling[b]

[a]Internal Medicine Department, University of São Paulo State, Botucatu School of Medicine-UNESP, São Paulo, Brazil;
[b]Division of Nephrology and Hypertension, Beth Israel Medical Center, New York, N.Y., USA

Advantages of PD

PD offers several advantages over hemodialysis, such as technical simplicity and a lack of bleeding risk. Because of its gradual and continuous nature, it prevents disequilibrium syndrome and has minimal cardiovascular stress, which reduces the risk of renal ischemia and fluid-electrolyte imbalance [3–5, 11–15].

Besides the classical indications (volume overload, electrolyte disorders, uremic symptoms, or acid-base disturbances), PD can also be used to maintain volemic control in patients with congestive heart failure functional class IV, control hyper- and hypothermia, and treat necrohemorrhagic pancreatitis with peritoneal lavage [3, 18].

In the setting of natural disasters such as earthquakes, when multiple victims will develop AKI and damage to infrastructure make access to power, clean water and facilities for water treatment unavailable, PD is an important and life-saving RRT modality [18, 19]. Table 3 shows advantages and disadvantages of PD.

Blood Purif 2012;34:107–116 DOI: 10.1159/000341648

Advances in Peritoneal Dialysis in Acute Kidney Injury

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[a]Internal Medicine Department, University of São Paulo State, Botucatu School of Medicine-UNESP, São Paulo, Brazil; [b]Division of Nephrology and Hypertension, Beth Israel Medical Center, New York, N.Y., USA

Conclusions

PD can be used successfully as an RRT modality to treat a selected group of AKI patients. PD is a simple, safe, gentle, and proven way to correct metabolic, electrolytic, acid-base, and volume disturbances generated by AKI. Recently, PD has shown a similar efficacy compared to dHD and hemodiafiltration in critically ill AKI patients. The use of PD techniques such as HVPD or CFPD or the association of PD and EBPT can provide adequate dialysis dose even in hypercatabolic situations.

Blood Purif 2012;34:107–116 DOI: 10.1159/000341648

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

- ***GUIDELINE A1*: Suitability of peritoneal dialysis for AKI in adults**
- **A1.1** Peritoneal dialysis should be considered as a suitable method of continuous renal replacement therapy in patients with acute kidney injury (1B).

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Indications for Acute PD

- **Renal Indications :**
  - ✓Hemodynamic unstable patients
  - ✓Bleeding diathesis or Hemorrhagic conditions
  - ✓Difficulty in obtaining blood access
  - ✓Clinical uremic syndrome : pericarditis , encephalopathy

PD advantages

1. Technique

- ✓simply & quickly
- ✓no highly trained personnel
- ✓no expensive & complex apparatus

2. Patients with AKI

- ✓Debilitated
- ✓Malnourished
- ✓Hemodynamically unstable

3. Systemic anticoagulation .. not needed

Relative contraindications for a Acute PD

1. Recent abdominal or cardiothoracic surgery
3. Fecal or fungal peritonitis
4. Severe respiratory failure
5. Abdominal wall cellulitis
6. Severe gastroesophageal reflux disease
7. Low peritoneal clearances
8. Life - threatening hyperkalemia
9. Severe acute pulmonary edema
10. Extremely high catabolysis

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Ttechniques of acute PD

- ***Catheter***
  - semi-rigid catheter
  - single/double -cuff Tenckhoff catheter
- ***PD catheter insertion technique***
  - Bedside Fluoroscopy
  - Miniexplore
- ***Exchange procedure***
  - *Manual/machine*

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A2: Access and fluid delivery for acute PD in adults

A2.1 Flexible peritoneal catheters should be used for acute PD where resources and expertise exist (**1C**) (Optimal). It may be necessary to use rigid stylet catheters or improvised catheters in resource-poor environments where they may still be lifesaving (**2D**) (Minimum standard).

A2.2 We recommend catheters should be tunneled in order to reduce peritonitis and peri-catheter leaks (**1D**).

A2.3 No method of insertion of PD catheter is superior to any other overall. We recommend that the method of implantation should be based on patient factors and local availability of skills, equipment, and consumables (**1D**).

A2.4 Peritoneal dialysis catheter insertion by nephrologists is safe and functional results equate to those inserted surgically (**1B**).

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ISPD GUIDELINES/RECOMMENDATIONS

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GUIDELINE A2: Access and fluid delivery for acute PD in adults

A2.5 We recommend that nephrologists receive training and be permitted to insert these catheters to ensure timely dialysis in the emergency setting (**1B**).

A2.6 Insertion of the Tenckhoff catheter should take place in the most sterile environment available, using sterile technique with the operator using gloves, gown and mask (**1D**).

A2.7 We recommend the use of prophylactic antibiotics prior to insertion of the Tenckhoff Catheter (**1C**).

A2.8 A closed fluid delivery system with a Y connection should be used (1A) (Optimal). In resource-poorareas spiking of bags and makeshift connections may be necessary (**2D**) (Minimum standard). It is imperative that strict asepsis be maintained throughout.

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Prescription of acute PD

1. Length of the dialysis session
2. Dialysate composition
3. Exchange volume
4. Exchange time
   - Inflow time
   - Dwell time
   - Outflow time
5. Additive to dilaysate
6. Catheter care
7. Monitoring

Prescription of acute PD

1. **length of the dialysis session**

- write PD orders for only 24 hours at a time

2. **dialysate composition**

Composition of peritoneal dialysis solutions

Sodium (mmol/L)	132–134
Potassium (mmol/L)	0–2
Calcium (mmol/L)	1.25–1.75
Magnesium (mmol/L)	0.25–0.75
Chloride (mmol/L)	95–106
Lactate (mmol/L)	35–40
Glucose (g/dL)	1.5–4.25
pH	5.5

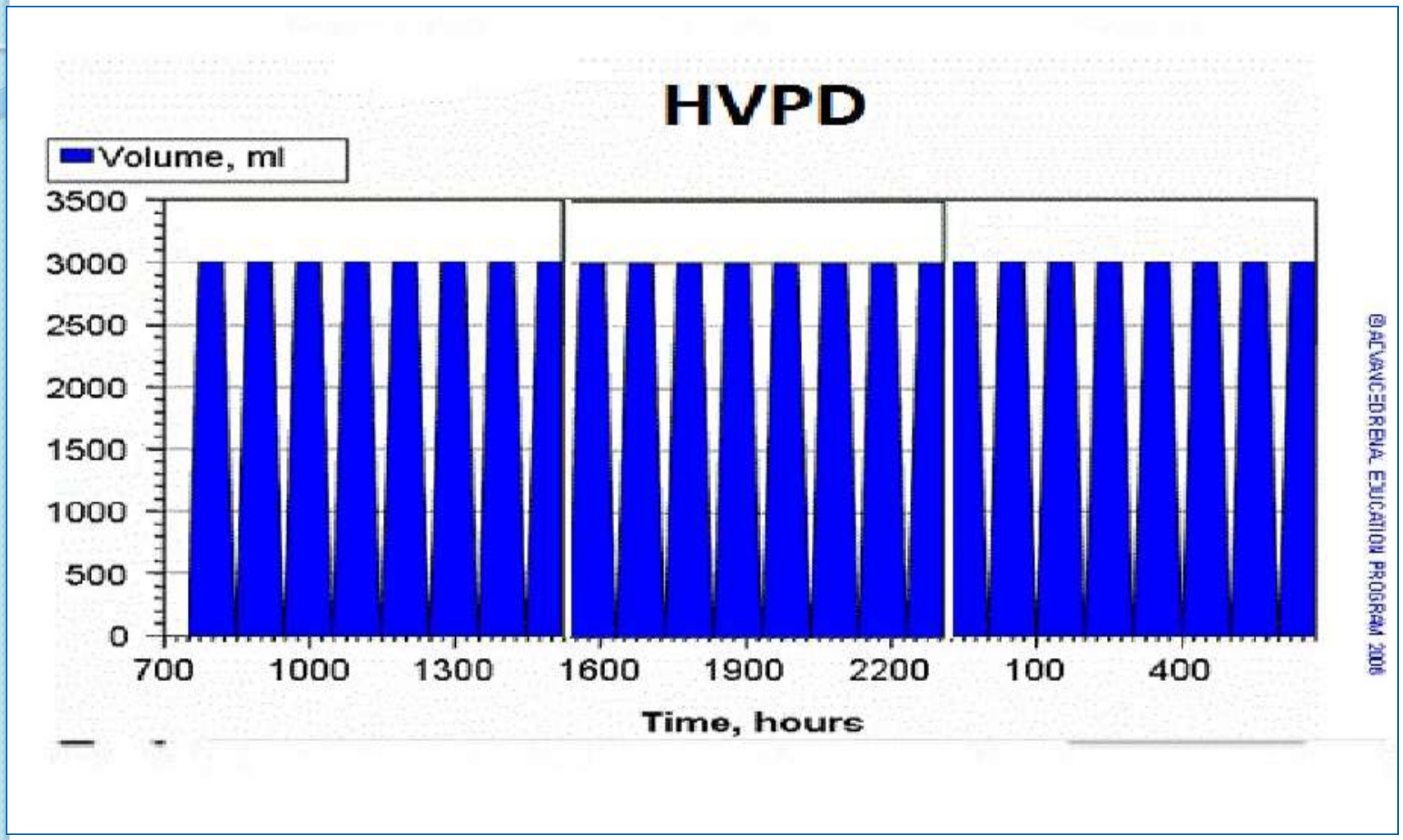
Prescription of acute PD

1. Length of the dialysis session
2. Dialysate composition
3. **Exchange volume**
4. Exchange time
   - Inflow time
   - Dwell time
   - Outflow time
5. Additive to dilaysate
6. Catheter care
7. Monitoring

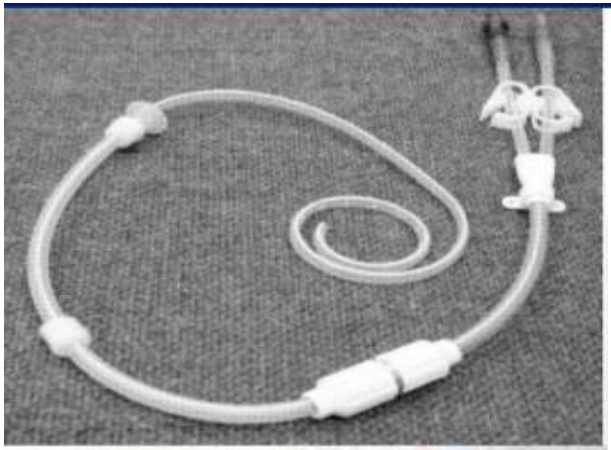
Exchange volume:

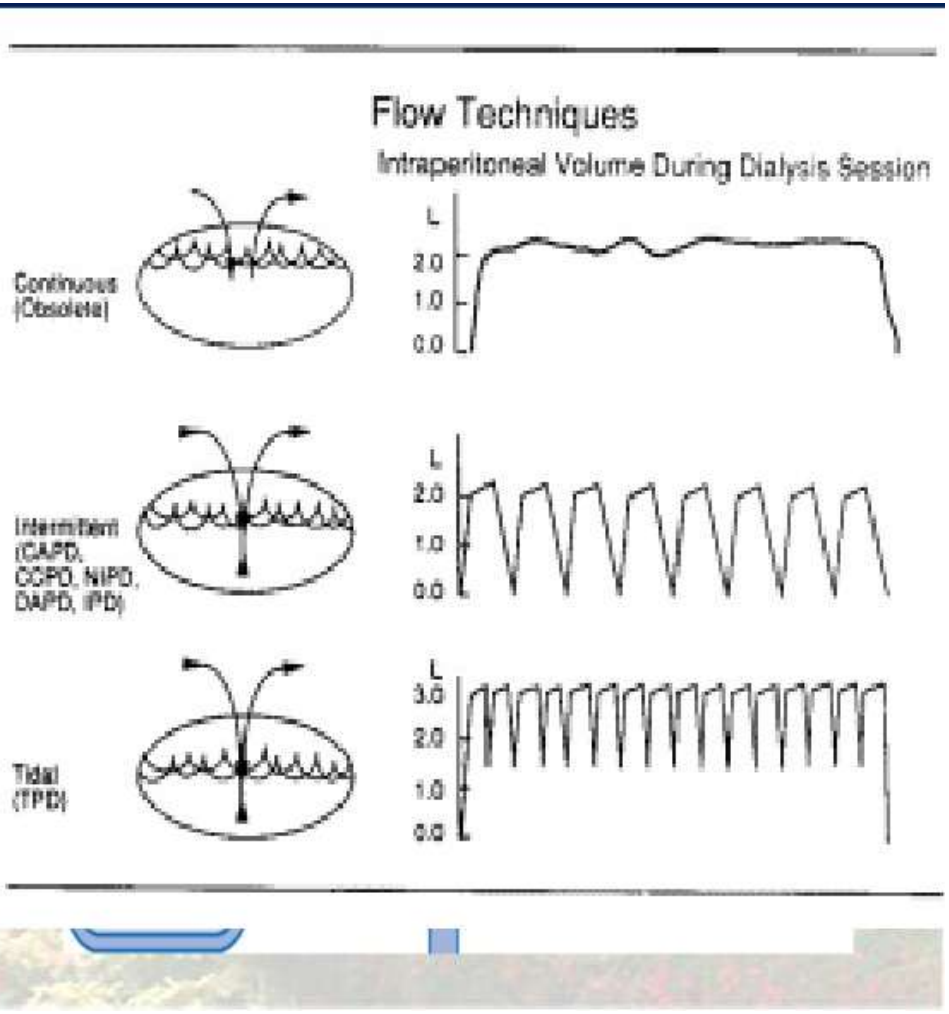
- Commonly 0.5 L – 2 L, adjusted
  - ✓size of patient's peritoneal cavity
  - ✓severity of uremic syndrome
- Start with small volume ➡ minimal leak
- Lager volume grater clearance
- Hypercatabolic : high volume/cycle

Treatment schedule



Continuous-flow peritoneal dialysis





High-Volume Peritoneal Dialysis in Acute Kidney Injury: Indications and Limitations

Daniela Ponce, Marina Nogueira Berbel, Cassiana Regina de Goes, Cibele Taís Puato Almeida, and André Luís Balbi

Summary

Background and objectives Peritoneal dialysis is still used for AKI in developing countries despite concerns about its limitations. The objective of this study was to explore the role of high-volume peritoneal dialysis in AKI patients in relation to metabolic and fluid control, outcome, and risk factors associated with death.

Design, setting, participants, & measurements A prospective study was performed on 204 AKI patients who were assigned to high-volume peritoneal dialysis (prescribed Kt/V=0.60/session) by flexible catheter and cycler; 150 patients (80.2%) were included in the final analysis.

Results Mean age was 63.8±15.8 years, 70% of patients were in the intensive care unit, and sepsis was the main etiology of AKI (54.7%). BUN and creatinine levels stabilized after four sessions at around 50 and 4 mg/dl, respectively. Fluid removal and nitrogen balance increased progressively and stabilized around 1200 ml and −1 g/d after four sessions, respectively. Weekly delivered Kt/V was 3.5±0.68. Regarding AKI outcome, 23% of patients presented renal function recovery, 6.6% of patients remained on dialysis after 30 days, and 57.3% of patients died. Age and sepsis were identified as risk factors for death. In urine output, increase of 1 g in nitrogen balance and increase of 500 ml in ultrafiltration after three sessions were identified as protective factors.

Conclusions High-volume peritoneal dialysis is effective for a selected AKI patient group, allowing adequate metabolic and fluid control. Age, sepsis, and urine output as well as nitrogen balance and ultrafiltration after three high-volume peritoneal dialysis sessions were associated significantly with death.

Clin J Am Soc Nephrol 7: 887–894, 2012. doi: 10.2215/CJN.11131111

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A4: Prescription of Acute PD

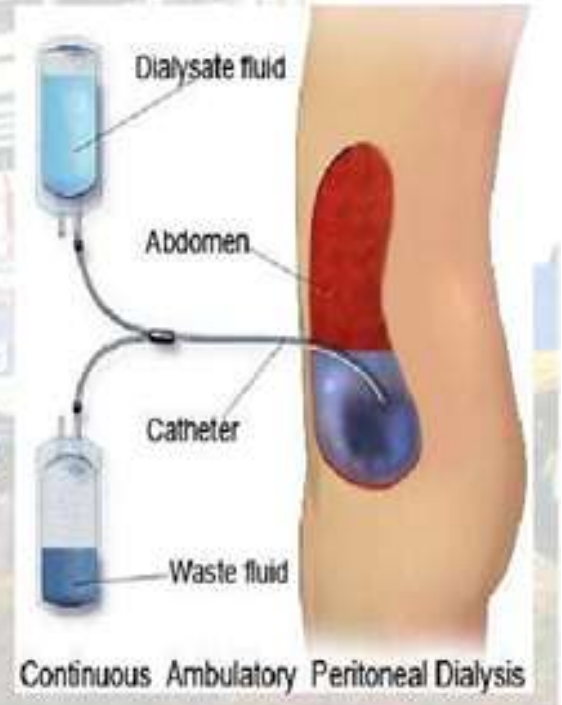
A4.1 Where resources permit, targeting a weekly Kt/V urea of 3.5 provides outcomes comparable to that of daily HD; targeting higher doses does not improve outcomes (**1B**). This dose may not be necessary for many patients with AKI and targeting a weekly Kt/V of 2.1 may be acceptable (**2D**).

Prescription of acute PD

1. Length of the dialysis session
2. Dialysate composition
3. Exchange volume
4. **Exchange time**
   - **Inflow time**
   - **Dwell time**
   - **Outflow time**
5. Additive to dilaysate
6. Catheter care
7. Monitoring

Exchange time

- **Combined time for inflow, dwell &drain**
  - most commonly used is 1 hour
  - inflow 10 minutes, dwell 30 minutes, outflow
  - 20 minutes.. 2-L exchange volume, 48 L of fluid /day
- **Inflow**
  - 10 min.(200ml/min.)
  - Depend on high-abdomen(manual)
- **Dwell**
  - Cataboic pt. : dwell 30 min.
  - More stable pt.: longer dwell
- **Drain(outflow)** 20-30 min.depend on
  - Total drained volume
  - Resistance out flow
  - Differrent .high pt-bag



Continuous Ambulatory Peritoneal Dialysis

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A4: Prescription of Acute PD

A4.2 During the initial 24 hours of therapy, the duration of cycle times needs to be dictated by the clinical circumstances. Short cycle times (every 1–2 hours) may be necessary in the first 24 hours to correct hyperkalemia, fluid overload, and/or metabolic acidosis. Thereafter, the cycle time may be increased to 4 – 6 hours depending on the clinical circumstances (**1D**).

P.D. solution

Made up of three essential compositions.

1 -Osmotic agent

2 -Electrolytes

3 -Acid – Base buffer

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A3: Peritoneal dialysis solutions for acute PD

A3.4 Commercially prepared solutions should be used (1C) (Optimal). However, where resources do not permit this, then locally prepared fluids may be lifesaving (2D). There is a high potential risk of contamination when preparing fluid and every effort should be made for this to be performed by pharmacists in a sterile environment not at the bedside (1D) (Minimum standard).

Bicarbonate / lactate combination buffer

Combination of **lactate** (*15 mmol/L*) **&** bicarbonate(*25 mmol/L*) Baxter

With osmalarity similar to glucose with P.H 7.4 . the bags are doubles chambered with glucose separated from Na bicarbonate and lactate.

Advantage:-

- Standard glucose exposure.
- Standard UF profile.
- Low GDP levels.
- Normal pH.
- Less peritonitis.
- Less inflow pain.

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A3: Peritoneal dialysis solutions for acute PD

A3.1 In patients with shock or liver failure, bicarbonate-containing solutions should be used (**1B**) (Optimal). Where these solutions are not available, the use of lactate-containing solutions is an alternative (**1D**) (Minimum standard).

Prescription of acute PD

1. Length of the dialysis session
2. Dialysate composition
3. Exchange volume
4. Exchange time
   - Inflow time
   - Dwell time
   - Outflow time
5. **Additive to dilaysate**
6. Catheter care
7. Monitoring

Additive to dialysate

1. Potassium: 3 - 5 mEq /L in PDF•Hypokalemia:
   - Non ptassium in solution
   - Correct acidosis
   - Glucose: shift potassium into cell
2. Heparin – 1000 - 2000 u/2 L prevent clot
3. Insulin
4. Antibiotics

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A3: Peritoneal dialysis solutions for acute PD

A3.3 Potassium levels should be measured daily (**1D**) (Optimal). Where these facilities do not exist, we recommend assessing the patient with regular electrocardiogram (ECG) recording and, after 24 hours, consider adding potassium to dialysate (**2D**) (Minimum standard).

Prescription of acute PD

1. Length of the dialysis session
2. Dialysate composition
3. Exchange volume
4. Exchange time
   - Inflow time
   - Dwell time
   - Outflow time
5. Additive to dilaysate
6. **Catheter care** : dressing & change everyday
7. Monitoring

Prescription of acute PD

1. Length of the dialysis session
2. Dialysate composition
3. Exchange volume
4. Exchange time
   - Inflow time
   - Dwell time
   - Outflow time
5. Additive to dilaysate
6. Catheter care
7. **Monitoring**

Monitoring

- **Fluid balance**
- **Clearance**
  - Electrolyte
  - BUN/Cr
  - Glucose

Prescription of acute PD

2 . dialysate composition: Choosing solution dextrose solution

- Alone/combination
- Rapid fluid removal : 4.25% 2-3 exchange→1.5%

Dextrose %	Solution osmolarity	UF ml/exchange	Volume L/day
1.5	346	50-150	1.2-3.6
2.5	396	100-300	2.4-7.2
4.25	483	300-400	7.2-9.6

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ISPD GUIDELINES/RECOMMENDATIONS

PERITONEAL DIALYSIS FOR ACUTE KIDNEY INJURY

GUIDELINE A4: Prescription of Acute PD

A4.3 Avoiding fluid overload is extremely important and ultrafiltration can be increased by raising the concentration of dextrose and/or shortening the cycle duration. When the patient is euvolemic, the dextrose concentration and cycle time should be adjusted to ensure a neutral fluid balance (1B).

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Complications of acute PD

1. Mechanical complications

2. Infectious complications

3. Medical complications

APPROACH TO THE METABOLIC IMPLICATIONS OF PERITONEAL DIALYSIS IN ACUTE KIDNEY INJURY

Main Metabolic Implications of Peritoneal Dialysis (PD)

Implication	Complication	Cause	Preventive action
Glucose absorption	Hyperglycemia	Glucose as PD osmotic agent	Use intravenous or intraperitoneal insulin
	Inadequate energy intake	Absent or inadequate estimate of glucose absorption	Proper quantification of glucose in dialysate
Protein loss	Malnutrition	Peritoneal semipermeable membrane	Minimum protein intake of 1.5 g/kg daily
	Hypoalbuminemia	Peritonitis	
Na removal	Hypernatremia	Difficulty of removing Na by HVPD because of rapid changes	Monitor blood Na Lower dialysate sodium Increase ultrafiltration
K removal	Hypokalemia	Considerable loss of K when using a large volume of dialysate with no K	Add K to PD bags
Catabolism	No control of hypercatabolism	Limited peritoneal Kt/V	Protein intake adequate to catabolism, aiming at neutral or positive nitrogen balance

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Outline

1. Introduction & evidence of PD in AKI
2. Indications for acute PD & Contraindications to acute PD
3. Techniques of acute PD & Treatment schedule
4. Prescription of acute PD
5. Complications of acute PD
6. **Acute PD in critically ill and hypercatabolic AKI patients**
7. Concept of combination dialysis

Comparison

Feature	PD	CRRT	IHD
Solute clearance	Adequate, but less than with other Modalities	Adequate	Adequate
Cost	Low	High	Moderate
Technical expertise required	Low	High	Moderate
Availability	Wide	Less	Moderate
Hypotensive patients	Yes	Yes	Maybe
Need for systemic anticoagulation	No	Yes	Yes

Comparison

Feature	PD	CRR	IHD
Need for central venous access	No	Yes	Yes
Delivers nutrition	Yes	No	No
Treatment of severe acute hyperkalemia	No	Maybe	Yes
Treatment of severe volume overload	Yes	Yes	Yes
Infections	Yes—peritonitis	Yes—line sepsis	Yes—line sepsis

Conclusions

- **Selected modality should be guide by individual patient clinical status, medical personnel expertise & available RRT modality.**
- **Renal programs should include an integrated PD/HD program where therapies are not competitive but rather complementary.**
- **PD is considered an option as RRT in AKI .**
- **PD remains a therapy :**
  - ✓ Easily
  - ✓ simply
  - ✓ Within &outside of ICU settings

Thank YOU

NMGH

NEPHROLOGY DEPARTEMENT
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